

A.D. 1865, 26th OCTOBER. N° 2765.

Testing and Working Submarine Electric Wires.

LETTERS PATENT to Willoughby Smith, of the Gutta Percha Works, Wharf Road, in the County of Middlesex, Electrical Engineer, for the Invention of "IMPROVEMENTS IN TESTING AND WORKING SUBMARINE ELECTRIC TELEGRAPH WIRES."

Sealed the 24th April 1866, and dated the 26th October 1865.

PROVISIONAL SPECIFICATION left by the said Willoughby Smith at the Office of the Commissioners of Patents, with his Petition, on the 26th October 1865.

I, WILLOUGHBY SMITH, of the Gutta Percha Works, Wharf Road, in the
5 County of Middlesex, Electrical Engineer, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN TESTING AND WORKING SUBMARINE ELECTRIC TELEGRAPH WIRES," to be as follows:—

My Invention consists in the arrangements hereafter described, whereby during the laying of the submarine telegraph a constant insulation test and
10 communications from the ship to the shore and from the shore to the ship may be maintained, and whereby the telegraph wires may be worked after the laying thereof. On board the ship I place the cable in communication with a galvanometer, and this galvanometer with a battery with a wire going to

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earth as has been already done, and consequently this part of the arrangement forms no part of my Invention. I connect the shore end of the cable with a resistance apparatus connected with a galvanometer which is in communication with the earth. I also employ and apply by means of a key to the shore end a current from one of two resistance coils or condensers of different power 5 for the purpose of speaking to the ship. For speaking from the ship to the shore reversed currents are transmitted from the ship.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Willoughby Smith in the Great Seal Patent Office on the 26th April 1866. [Title amended by order of the Lord Chancellor, 2nd 10 May 1866.]

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, WILLOUGHBY SMITH, of the Gutta Percha Works, Wharf Road, in the County of Middlesex, Electrical Engineer, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters 15 Patent, bearing date the Twenty-sixth day of October, in the year of our Lord One thousand eight hundred and sixty-five, in the twenty-ninth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Willoughby Smith, Her special licence that I, the said Willoughby Smith, my executors, administrators, and assigns, or such others as I, the 20 said Willoughby Smith, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "**Im- 25**
PROVEMENTS IN TESTING AND WORKING SUBMARINE ELECTRIC TELEGRAPH WIRES," upon the condition (amongst others) that I, the said Willoughby Smith, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was 30 to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Willoughby Smith, do hereby declare the nature of my said Invention, and in what manner the same is to be 35

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performed, to be particularly described and ascertained in and by the following statement thereof, reference being had to the Drawings hereunto annexed, that is to say :—

While submerging electric telegraph cables it has hitherto been the practice
5 to devote certain portions of each hour to the different electrical tests which it has been considered necessary to make ; for instance, during the laying of the Atlantic cable the hour was divided into four parts, and a certain test had to be repeated every hour at the time allotted to it. In this instance the first thirty minutes were occupied on shipboard in testing the insulation or resistance
10 of the gutta percha, as shewn in Figure 1 of the accompanying Diagrams, in which C represents the cable ; G, the galvanometer ; and B, the battery. The other thirty minutes were divided into three equal parts, which were devoted respectively to receiving reversals from the shore, ascertaining the resistance of the conductor, and sending reversals to the shore ; these tests are respec-
15 tively represented in Figures 2, 3, and 4. The most important tests, and the only tests which are absolutely necessary during the submerging of a cable, are those for insulation and for the continuity of the conductor. A ready means of immediate communication between the ship and the shore is always desirable. Hitherto each test has been applied independently, that is to say,
20 while the continuity test was being made the insulation has had to be neglected, and vice versâ. Consequently in the arrangements above mentioned the state of the insulation of the cable was not known during the last thirty minutes of each hour. The danger attending the intermittent discontinuance of this test during one half the time occupied in laying the cable is
25 evident, as it should be perpetually maintained.

Now the primary object of this Invention is to enable the electrician in charge of a submarine electric telegraph cable, more especially while it is being submerged, to keep up a constant test for insulation and continuity, and at the same time to communicate freely through the cable between the
30 ship and the shore.

Before proceeding to explain the manner in which I carry my Invention into effect, I may remark, in order to assist in explaining my Invention, that were it possible for a submarine electric cable with the water surrounding it to be placed in an insulated trough, not only could the resistance of the
35 dielectric enveloping the conductor be arrived at by measuring the amount of current passing into the cable after a certain time has been allowed for electrification (which constitutes the ordinary insulation test), but also by merely placing a wire from one terminal of a galvanometer in connection with the water, and a similar wire in connection with the other terminal to

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earth, the actual amount of current passing out of the cable through the dielectric could be measured, and thus tests could be made by two separate persons quite independently of each other. Although such an arrangement as that just described is impracticable as regards the entire cable there would be no difficulty in placing a few miles of the coil at one end of a cable under 5 the conditions explained, and these would be sufficient for the purpose of my Invention. But I attain my object in a much more convenient and cheaper way. I construct and employ a resistance apparatus, which may be varied so as to equal that of the dielectric of any length of the cable. While taking an ordinary insulation test the distant end of the electric conductor has to be 10 insulated, or isolated from all surrounding conductors, as shewn in Figure 1.

Now to carry out my Invention I attach an insulated plate or a series of plates of any good conducting material to the free end of the conductor, and between such plates I place a thin sheet or sheets of a material of comparatively high electric resistance, paper or dry wood saturated with an 15 insulating material or gelatine in thin sheets answers the purpose. Suppose I employ a series of six metal plates, then each alternate plate is connected to the conductor of the cable, and the remaining three are connected with the earth through a galvanometer. Consequently the amount of current which passes through the material placed between the copper plates flows 20 through the galvanometer to earth, and thus a constant deflection is registered as long as the line is kept charged at a uniform tension. But if the tension should alter, or the direction of the current be reversed, the change in the deflection is immediately noticed, and by this means the person in charge of the batteries, by a pre-arranged code of signals, communicates with the 25 person in charge of the galvanometer without interfering with the insulation test. Thus, if it is arranged to work with the Morse code, the deflection to the right hand may be used to represent the dot, and the deflection to the left hand, caused by reversing the current, may represent the dash; or the same code may be worked readily by altering the tension, and thus causing 30 high or low deflection, which may be considered as representing dots and dashes. This latter method has an advantage over the former, inasmuch as the cable can always be charged from the copper end of the battery, which is most desirable in long submarine lines. To enable the person in charge of the distant galvanometer to communicate with the battery station a resistance, 35 which in this case I prefer to be made of very fine silk-covered wire (by preference, German silver wire) has one of its ends attached to the stud of an ordinary contact key, and the other end to earth, the conductor of the cable being in contact with the key. Therefore when the key is pressed down to

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the stud a portion of the current from the charged cable passes through the resistance coil to earth, thus causing an increased deflection on the galvanometer at the battery station. By varying the amount of resistance, or the duration of the contact, deflections representing dots and dashes can be
5 produced. Where I have indicated the employment of resistance, condensers may in each instance be substituted, and in this case every alteration in the tension, or the reversal of the current, will cause a very sudden and strong deflection on the distant galvanometer. This being an inductive effect the deflection will be in proportion to the size of the condenser. While laying a
10 submarine telegraph cable the batteries and testing apparatus should be on board the cable ship. On shore the end of the conductor of the cable should be joined to a resistance which allows only sufficient current to pass to give a distinct reading on a much more sensitive galvanometer than that used on the ship. In fact the leakage through the resistance should be such as in no
15 way to interfere with the insulation test. The resistance used on shore for the continuity test should be of sufficient magnitude to make it impossible to increase the deflection on the ship galvanometer beyond a certain limit.

The working of this system will be fully understood on reference to
20 Figure 5, which represents an arrangement of apparatus suitable for carrying my Invention into effect; G is the ship galvanometer; B and B¹ are batteries of the same tension, but so connected to keys K and K¹ that the cable can be conveniently charged from either the copper of the one or the zinc of the other; R is a resistance attached to the shore end of the conductor and the
25 galvanometer G¹, the other terminal of this galvanometer being connected to the earth; r and r^1 are resistances which can be brought into contact with the conductor at will by means of the key K¹¹. The galvanometers G and G¹ are by preference mirror-reflecting galvanometers. Suppose the cable to be charged from the battery B, by pressing the key K, after, say one
30 minute's electrification, the reading on the galvanometer G will be, say 50 divisions, and that on the galvanometer G¹, 130 divisions. The resistance R may be disconnected and reconnected repeatedly, without in any way altering the reading of the galvanometer G. If the key K¹¹ be brought into contact with the resistance r , for say the fifth part of a second, the deflection on the
35 galvanometer G will be increased, and by regulating the time of contact the image can be placed at any desired part of the scale, or letters may be substituted for the figures on the scale, and thus a very quick and simple system of telegraphing will be obtained. Reversals may be employed to reverse the deflection on the galvanometer G¹. Communication between the

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two instruments is thus complete without in any way interfering with the insulation test. When charging with reversals, to alter the deflection on the galvanometer G^1 , it is best to place a shunt on the galvanometer G , in case the full charge should injure that instrument.

Figure 6 represents a set of apparatus arranged according to my system 5 for working through the cable after the same has been laid; C represents the cable; R and R^1 are resistances, with respective galvanometers G and G^1 attached in connection with the conductor of the cable; keys K and K^1 (connected to batteries B and B^1 respectively by one of their studs) are also attached to the conductor. The remaining studs of the keys are respectively connected 10 to artificial cables A and A^1 , the inductive capacity and resistance of which can be altered at will. The galvanometers H , H^1 , and N , N^1 , have letters or other convenient signs placed in the range of their respective magnets, or in the range of the image from the same, if mirror galvanometers are used. Suppose a cable to be laid between England and America, and the arrange- 15 ments to be at each station, as represented in Figure 6. To communicate with England, the operator in America charges the cable by pressing the key K down on the stud connected with the battery B , which causes an immediate deflection on the galvanometer G^1 in England, and the operator there at once connects his battery to the line by means of the key K^1 , and is thus 20 ready to receive. As soon as the increased deflection on the galvanometer at the American station shows that the call has been noticed the operator there releases the key K from the batteries and proceeds as follows:—By pressing the key K down to the stud in connection with A a small portion of the current leaves the cable and passes through the galvanometer 25 H to earth. The increase of the deflections on the galvanometers H and N^1 are in proportion to the length of time allowed for contact. Consequently if the instruments H and N^1 are properly adjusted, it follows that if the contact is maintained until the magnet or image points to the desired letter on the scale of the galvanometer H , the same letter will be indicated on the 30 galvanometer N^1 at the distant station. Thus any alphabet or code can be employed with certainty and comparative rapidity, and the line never charged except from the copper plate of the battery.

And having now described the nature of my said Invention, and in what manner the same is to be performed, I declare that I claim,—

First, the arrangement, substantially as herein-before described, whereby during the laying of submarine electric telegraph wires a constant insulation and continuity test and free and unbroken communication between the ship and the shore may be maintained.

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Second, the arrangement, substantially as herein-before described, whereby submarine electric telegraph wires may be worked after the laying thereof.

5 In witness whereof, I, the said Willoughby Smith, have hereunto set my hand and seal, the Twenty-fifth day of April, One thousand eight hundred and sixty-six.

WILLOUGHBY SMITH. (L.S.)

LONDON :

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Printers to the Queen's most Excellent Majesty. 1866.

FIG. 1.

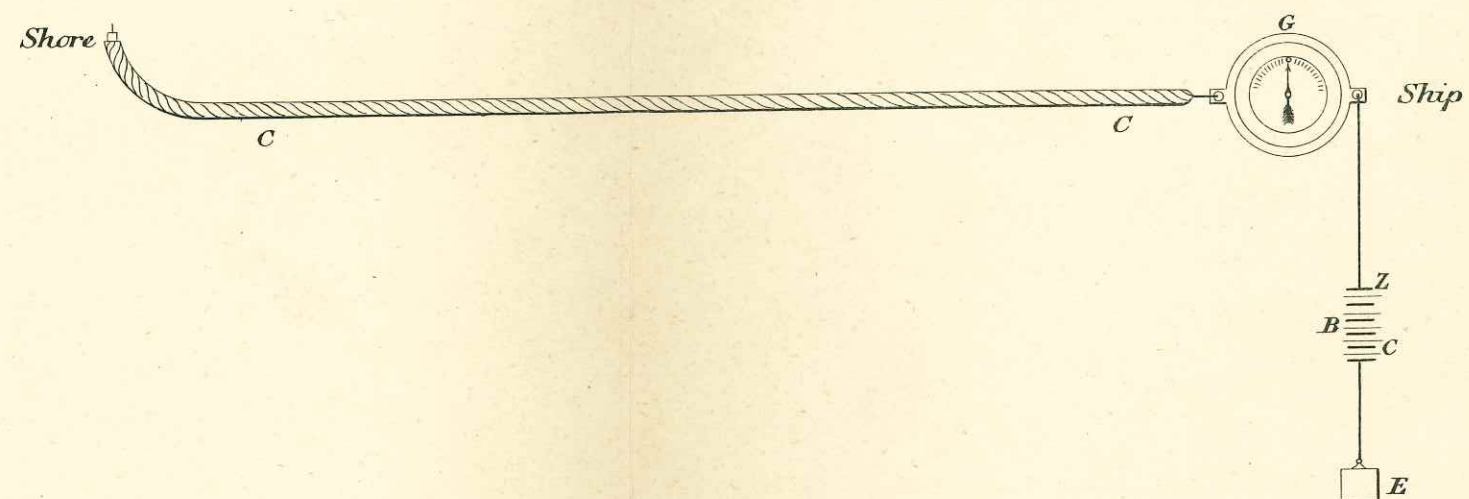


FIG. 2.

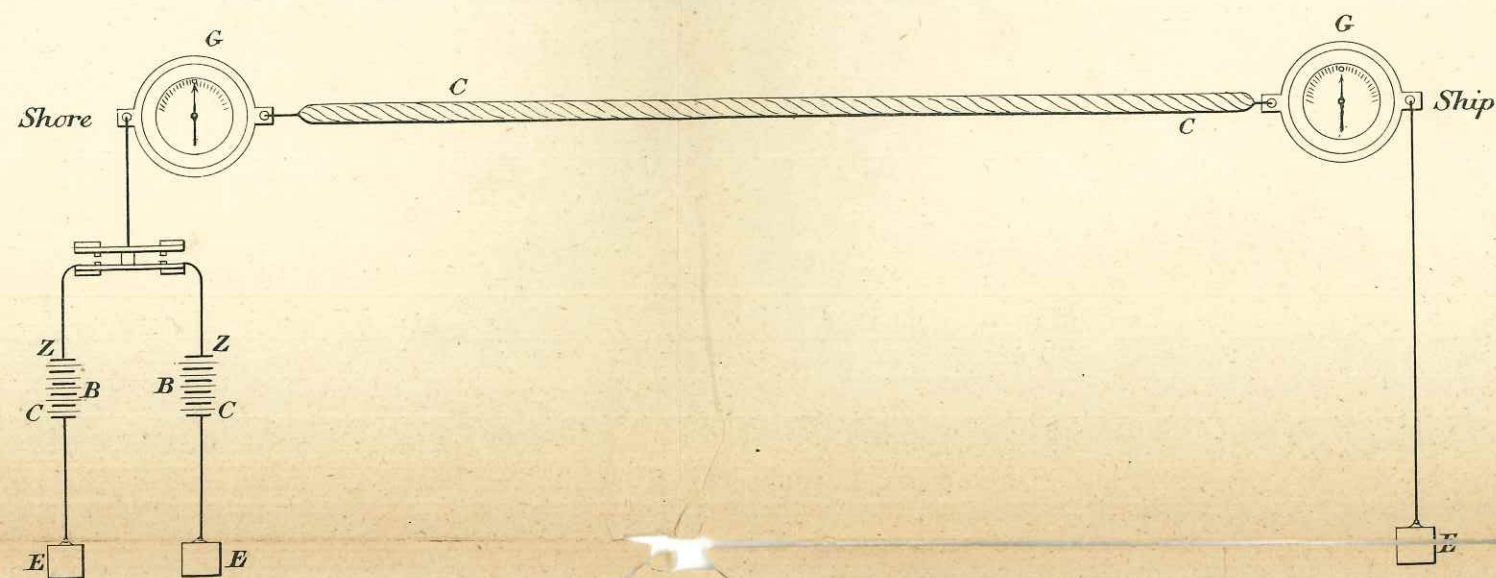


FIG. 3.

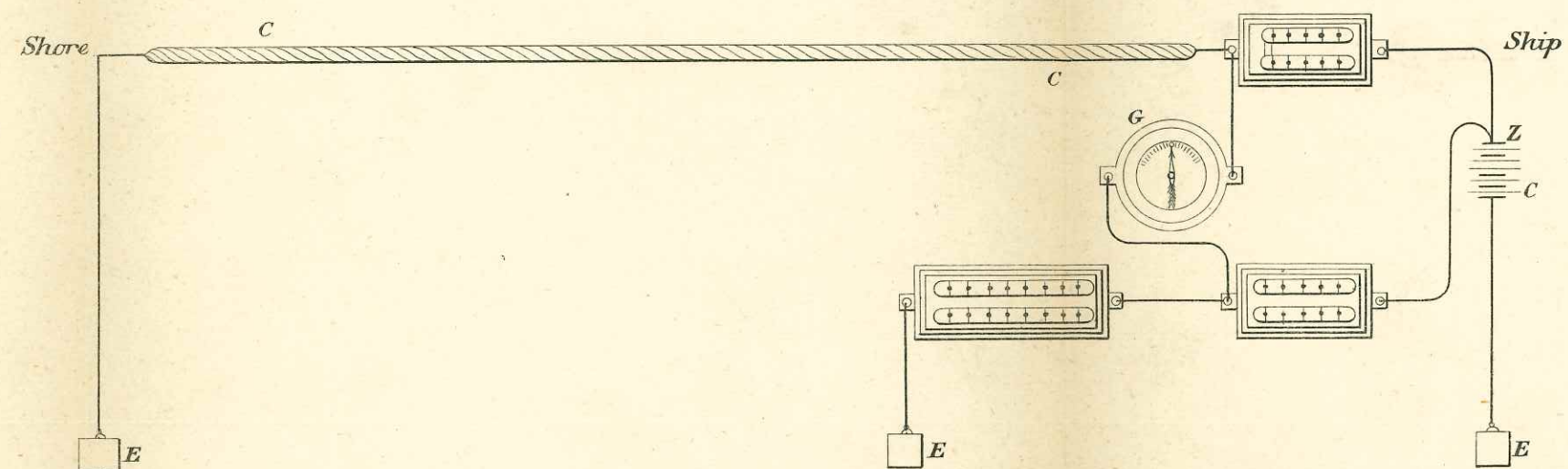
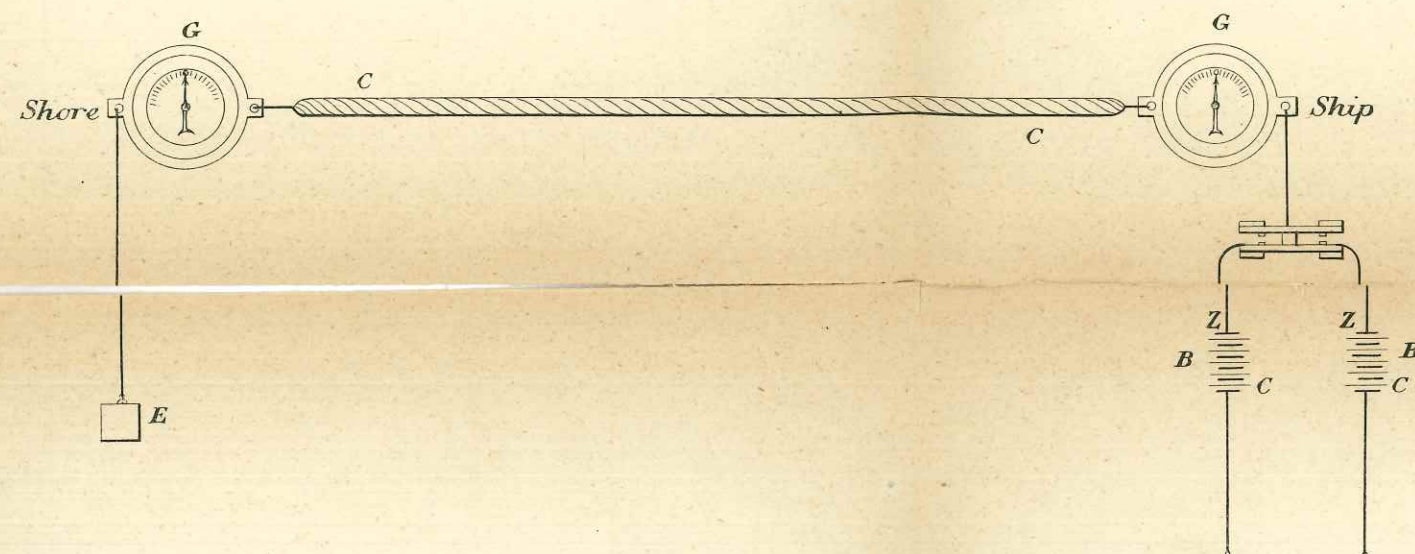


FIG. 4.



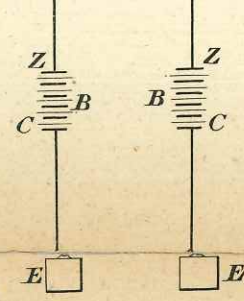
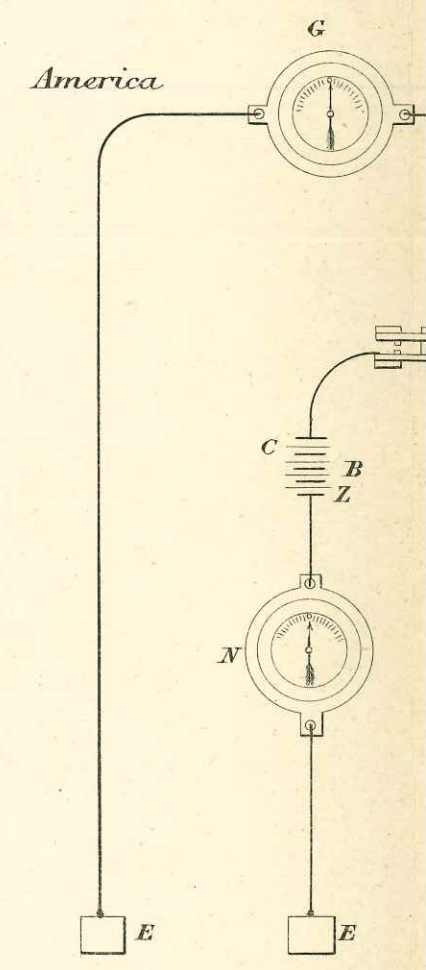
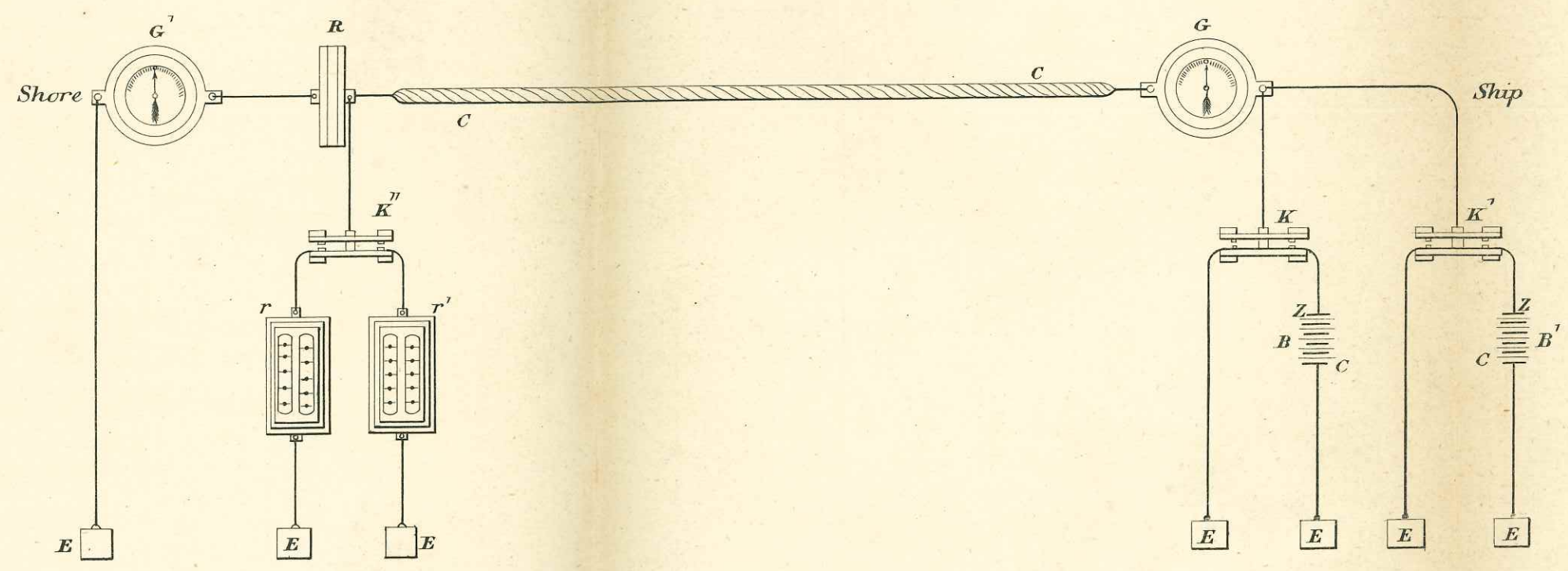


FIG. 5.



The filed drawing is not colored

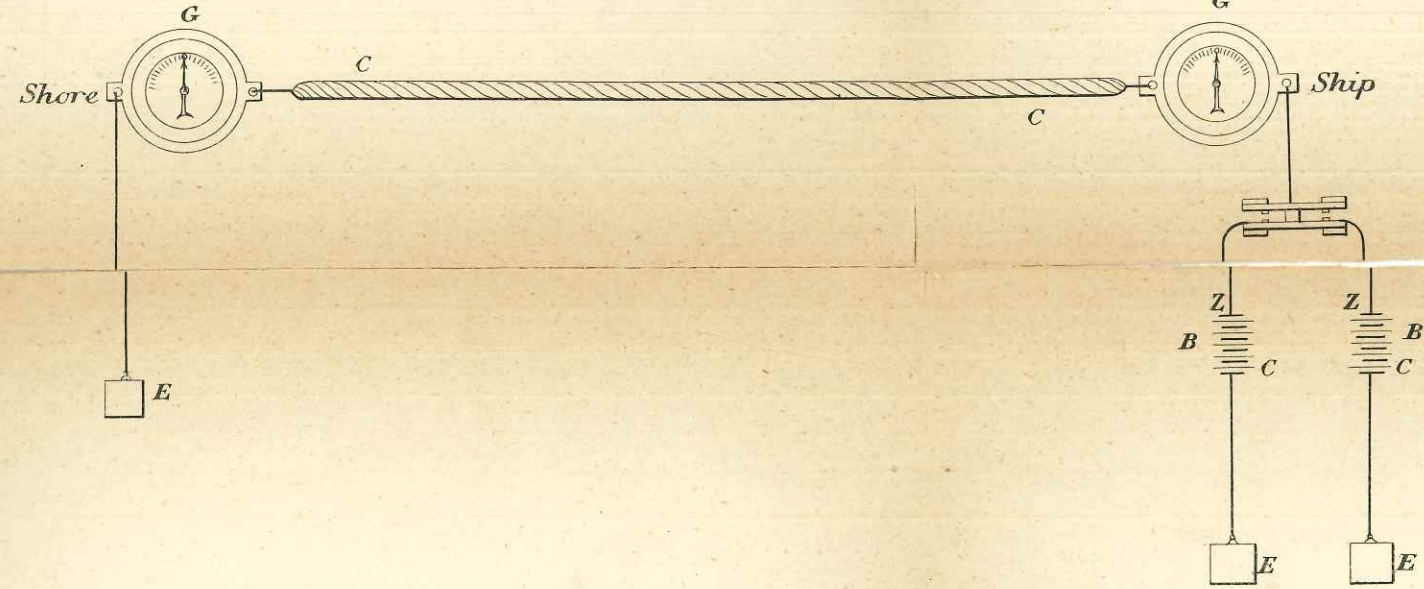
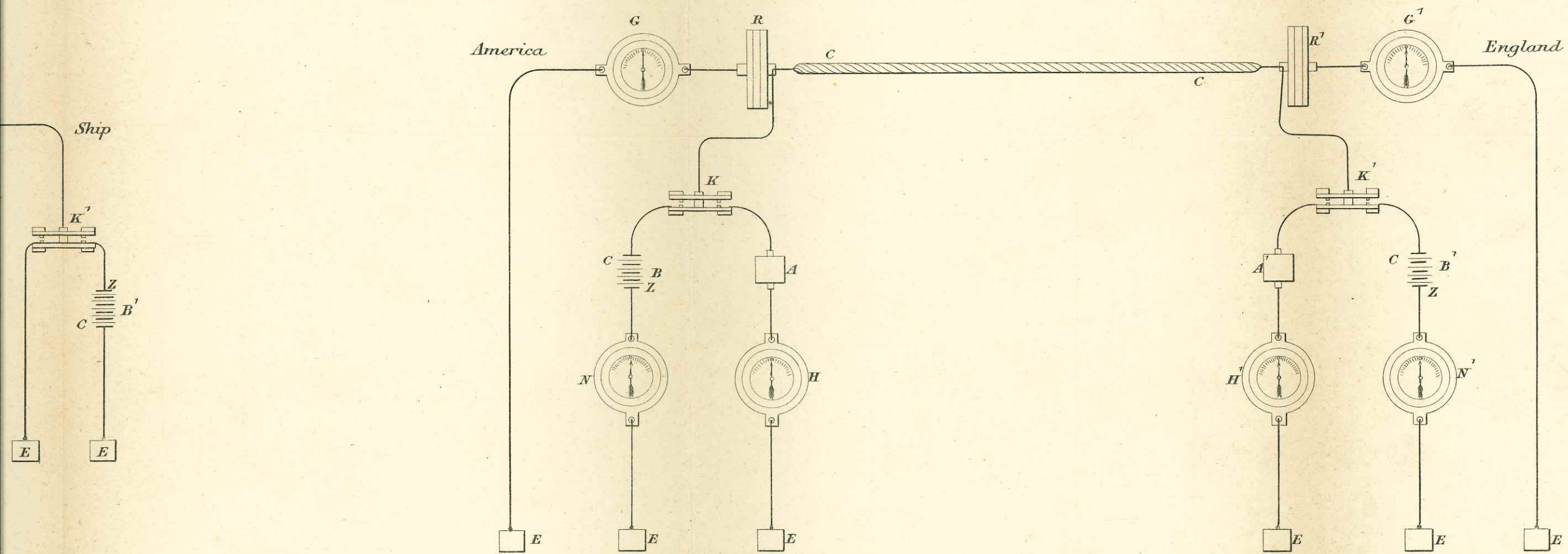


FIG. 6.



Drawn on Stone by Malby & Sons.